

Band structure and omnidirectional extraction by photonic crystals in GaN

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Photonic Crystals (PhCs) offer a great potential to solve the long-standing issue of light extraction from a solid-state structure, notably for Light-Emitting Diodes [1,2]. However, efficient means to turn a guided mode into a radiative mode are still unclear. GaN-based LEDs are recognized as the most promising devices towards high-efficiency for display and lighting applications. We carried out a theoretical and experimental study of diffractive 2D photonic crystals fabricated on InGaN/GaN-based heterostructures, which support multiple guided modes due to the thick (several μm) GaN layer. PhC parameters were chosen in accordance with theoretical predictions to favor diffraction below the second gap. Angular-resolved photoluminescence experiments clearly reveal the rich physics of guided light diffraction taking into account in-plane angles, and they give access to the band structure of the radiative PhC modes. An impressive correlation is further obtained with full 3D-modelling : we identify all measured bands and give proof of the truly 2D effect of the PhC, well beyond simpler 1D diffractive gratings. Remarkably, it turns out that efficient omnidirectional light-extraction by a simple triangular lattice is possible, which had not been expected so far in substrate-based heterostructures.

[1] "Omnidirectional and compact guided light extraction from Archimedean photonic lattices", M. Rattier et al., *Appl. Phys. Lett.* **83** (1283), 2003

[2] "Light extraction from optically pumped light-emitting diode by thin-slab photonic crystals", M. Boroditsky et al., *Appl. Phys. Lett.* **75** (1036), 1999

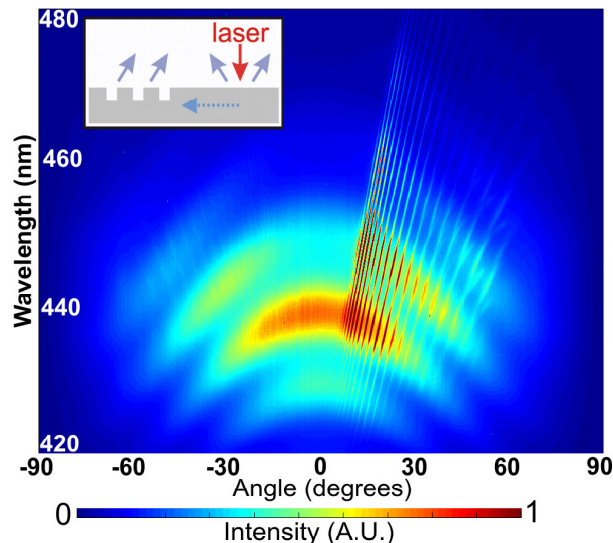


Figure 1 : Experimental setup (inset) and angular-resolved photoluminescence spectrum of the PhC sample. The sharp lines on the right-hand side of the spectrum manifest diffraction by the PhC.